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BIPOLAR ANALOG INTEGRATED CIRCUIT

μPC8187TB

SILICON MMIC HI-IP3 FREQUENCY UP-CONVERTER FOR WIRELESS TRANSCEIVER

DESCRIPTION

The μPC8187TB is a silicon monolithic integrated circuit designed as frequency up-converter for wireless transceiver. This IC is higher operating frequency, lower distortion and higher conversion gain than conventional μPC8163TB.

This IC is manufactured using NEC's 30 GHz f_{max} UHS0 (Ultra High Speed Process) silicon bipolar process.

FEATURES

- High output frequency : f_{RFout} = 0.8 to 2.5 GHz
- High-density surface mounting : 6-pin super minimold package
- Supply voltage : V_{CC} = 2.7 to 3.3 V
- Higher IP_3 : OIP_3 = +10 dBm @ f_{RFout} = 1.9 GHz

APPLICATION

- TDMA, PCS, CDMA etc.

ORDERING INFORMATION

Part Number	Package	Marking	Supplying Form
μPC8187TB-E3-A	6-pin super minimold	C3G	• Embossed tape 8 mm wide. • Pin 1, 2, 3 face the tape perforation side. • Qty 3 kpcs/reel.

Remark To order evaluation samples, please contact your local sales office.
(Part number for sample order: μPC8187TB-A)

Caution Electro-static sensitive devices

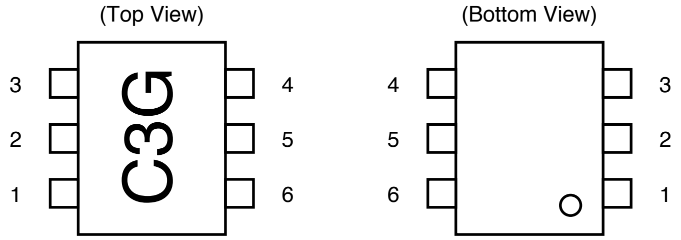
The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.

Document No. P15106EJ2V0DS00 (2nd edition)
Date Published January 2001 N CP(K)

The mark ★ shows major revised points.

CONTENTS

1. PIN CONNECTIONS



Pin No.	Pin Name
1	IFinput
2	GND
3	LOinput
4	GND
5	V_{CC}
6	RFoutput

2. SERIES PRODUCTS (T_A = +25°C, V_{CC} = V_{PS} = V_{RFout} = 3.0 V, Z_S = Z_L = 50 Ω)

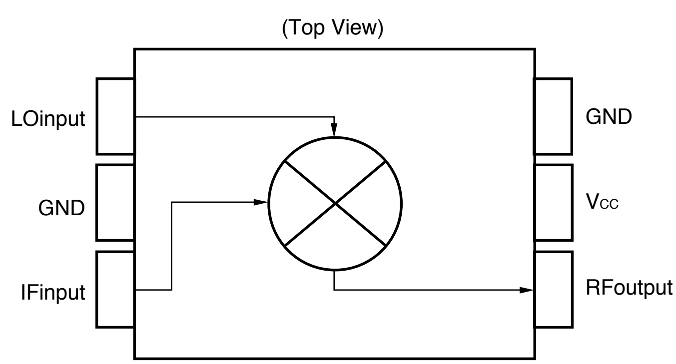
Part Number	I_{CC} (mA)	f_{RFout} (GHz)	CG (dB)		
			@RF 0.9 GHz Note	@RF 1.9 GHz	@RF 2.4 GHz
μPC8187TB	15	0.8 to 2.5	11	11	10
μPC8106TB	9	0.4 to 2.0	9	7	–
μPC8172TB	9	0.8 to 2.5	9.5	8.5	8.0
μPC8109TB	5	0.4 to.2.0	6	4	–
μPC8163TB	16.5	0.8 to 2.0	9	5.5	–

Part Number	$P_{O(sat)}$ (dBm)			OIP_3 (dBm)		
	@RF 0.9 GHz Note	@RF 1.9 GHz	@RF 2.4 GHz	@RF 0.9 GHz Note	@RF 1.9 GHz	@RF 2.4 GHz
μPC8187TB	+4	+2.5	+1	+10	+10	+8.5
μPC8106TB	–2	–4	–	+5.5	+2.0	–
μPC8172TB	+0.5	0	–0.5	+7.5	+6.0	+4.0
μPC8109TB	–5.5	–7.5	–	+1.5	–1.0	–
μPC8163TB	+0.5	–2	–	+9.5	+6.0	–

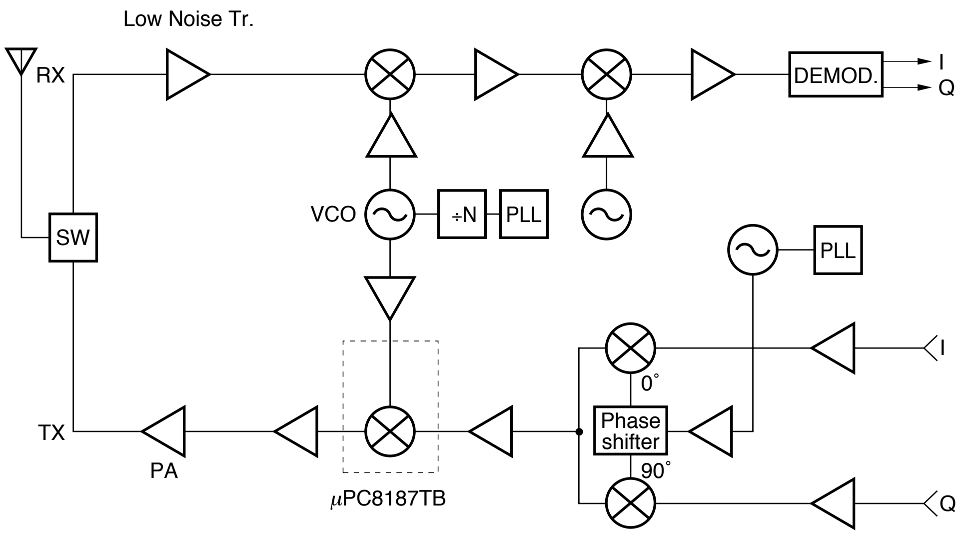
Note f_{RFout} = 0.83 GHz @ μPC8163TB and μPC8187TB

Remark Typical performance. Please refer to **8. ELECTRICAL CHARACTERISTICS** in detail.
To know the associated product, please refer to each latest data sheet.

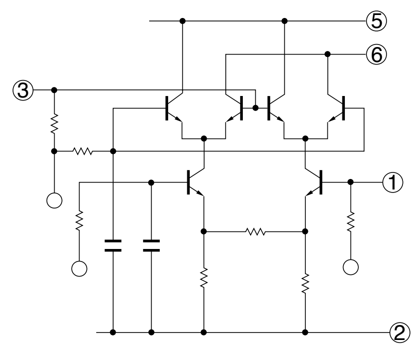
3. BLOCK DIAGRAM



4. SYSTEM APPLICATION EXAMPLES (SCHEMATICS OF IC LOCATION IN THE SYSTEM)



5. PIN EXPLANATION

Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V)[Note]	Function and Explanation	Equivalent Circuit
1	IFinput	–	1.2	This pin is IF input to double balanced mixer (DBM). The input is designed as high impedance. The circuit contributes to suppress spurious signal. Also this symmetrical circuit can keep specified performance insensitive to process-condition distribution. For above reason, double balanced mixer is adopted.	
2 4	GND	GND	–	GND pin. Ground pattern on the board should be formed as wide as possible. Track Length should be kept as short as possible to minimize ground impedance.	
3	LOinput	–	2.1	Local input pin. Recommendable input level is −10 to 0 dBm.	
5	V_{CC}	2.7 to 3.3	–	Supply voltage pin.	
6	RFoutput	Same bias as V_{CC} through external inductor	–	This pin is RF output from DBM. This pin is designed as open collector. Due to the high impedance output, this pin should be externally equipped with LC matching circuit to next stage.	

Note Each pin voltage is measured at $V_{CC} = V_{RFout}$ = 2.8 V.

6. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Test Conditions	Rating	Unit
Supply Voltage	V_{CC}	T_A = +25°C	3.6	V
Power Dissipation	P_D	Mounted on double-side copperclad 50 × 50 × 1.6 mm epoxy glass PWB, T_A = +85°C	270	mW
Operating Ambient Temperature	T_A		–40 to +85	°C
Storage Temperature	T_{stg}		–55 to +150	°C
Maximum Input Power	P_{in}		+10	dBm

7. RECOMMENDED OPERATING RANGE

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Remarks
Supply Voltage	V_{CC}	2.7	2.8	3.3	V	The same voltage should be applied to pin 5 and 6
Operating Ambient Temperature	T_A	–40	+25	+85	°C	
Local Input Power	P_{LOin}	–10	–5	0	dBm	Z_S = 50 Ω (without matching)
RF Output Frequency	f_{RFout}	0.8	–	2.5	GHz	With external matching circuit
IF Input Frequency	f_{IFin}	50	–	400	MHz	

8. ELECTRICAL CHARACTERISTICS

(T_A = +25°C, V_{CC} = V_{RFout} = 2.8 V, f_{IFin} = 150 MHz, P_{LOin} = –5 dBm)

Parameter	Symbol	Test Conditions Note	MIN.	TYP.	MAX.	Unit
Circuit Current	I_{CC}	No signal	11	15	19	mA
Conversion Gain	CG1	f_{RFout} = 0.83 GHz, P_{IFin} = –20 dBm	8	11	14	dB
	CG2	f_{RFout} = 1.9 GHz, P_{IFin} = –20 dBm	8	11	14	dB
	CG3	f_{RFout} = 2.4 GHz, P_{IFin} = –20 dBm	7	10	13	dB
Saturated Output Power	$P_{O(sat)}1$	f_{RFout} = 0.83 GHz, P_{IFin} = 0 dBm	+1.5	+4	–	dBm
	$P_{O(sat)}2$	f_{RFout} = 1.9 GHz, P_{IFin} = 0 dBm	0	+2.5	–	dBm
	$P_{O(sat)}3$	f_{RFout} = 2.4 GHz, P_{IFin} = 0 dBm	–1.5	+1	–	dBm

Note $f_{RFout} < f_{LOin}$ @ f_{RFout} = 0.83 GHz
$f_{LOin} < f_{RFout}$ @ f_{RFout} = 1.9 GHz/2.4 GHz

9. OTHER CHARACTERISTICS, FOR REFERENCE PURPOSES ONLY

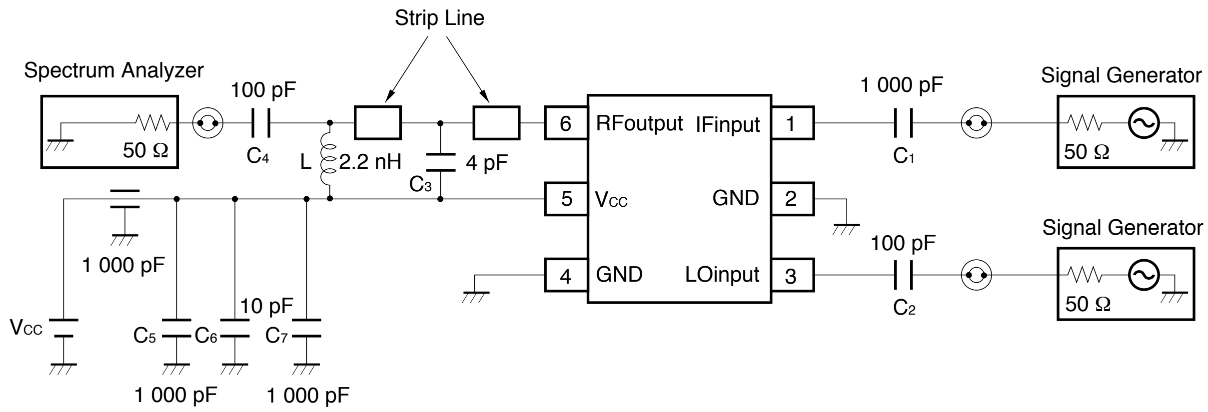
(T_A = +25°C, V_{CC} = V_{RFout} = 2.8 V, P_{LOin} = −5 dBm)

Parameter	Symbol	Test Conditions[Note]		Value	Unit
Output 3rd Order Distortion Intercept Point	OIP$_3$1	f_{RFout} = 0.83 GHz	f_{IFin}1 = 150 MHz, f_{IFin}2 = 151 MHz	+10	dBm
	OIP$_3$2	f_{RFout} = 1.9 GHz		+10	dBm
	OIP$_3$3	f_{RFout} = 2.4 GHz		+8.5	dBm
Input 3rd Order Distortion Intercept Point	IIP$_3$1	f_{RFout} = 0.83 GHz	f_{IFin}1 = 150 MHz, f_{IFin}2 = 151 MHz	−1.0	dBm
	IIP$_3$2	f_{RFout} = 1.9 GHz		−1.0	dBm
	IIP$_3$3	f_{RFout} = 2.4 GHz		−1.5	dBm
SSB Noise Figure	SSB•NF1	f_{RFout} = 0.83 GHz	f_{IFin} = 150 MHz	11	dB
	SSB•NF2	f_{RFout} = 1.9 GHz		12	dB
	SSB•NF3	f_{RFout} = 2.4 GHz		12.5	dB

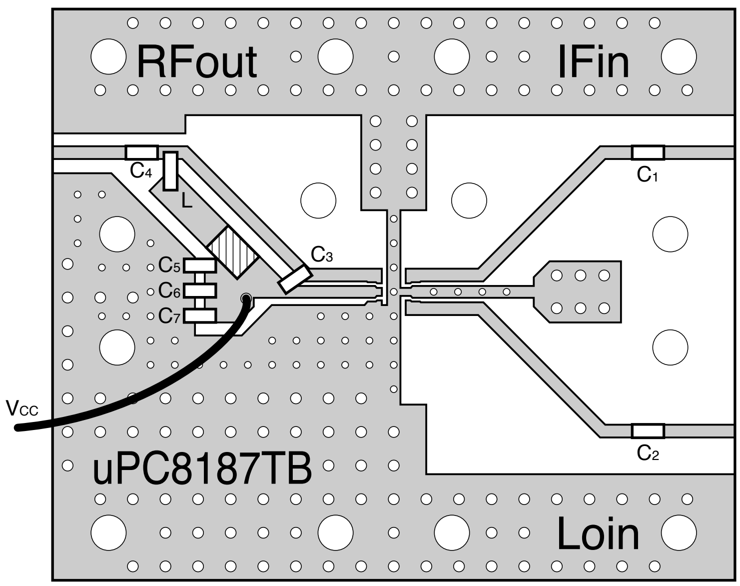
Note $f_{RFout} < f_{LOin}$ @ f_{RFout} = 0.83 GHz
$f_{LOin} < f_{RFout}$ @ f_{RFout} = 1.9 GHz/2.4 GHz

★ 10. TEST CIRCUITS

10.1 TEST CIRCUIT 1 (f_{RFout} = 0.83 GHz)



EXAMPLE OF TEST CIRCUIT 1 ASSEMBLED ON EVALUATION BOARD



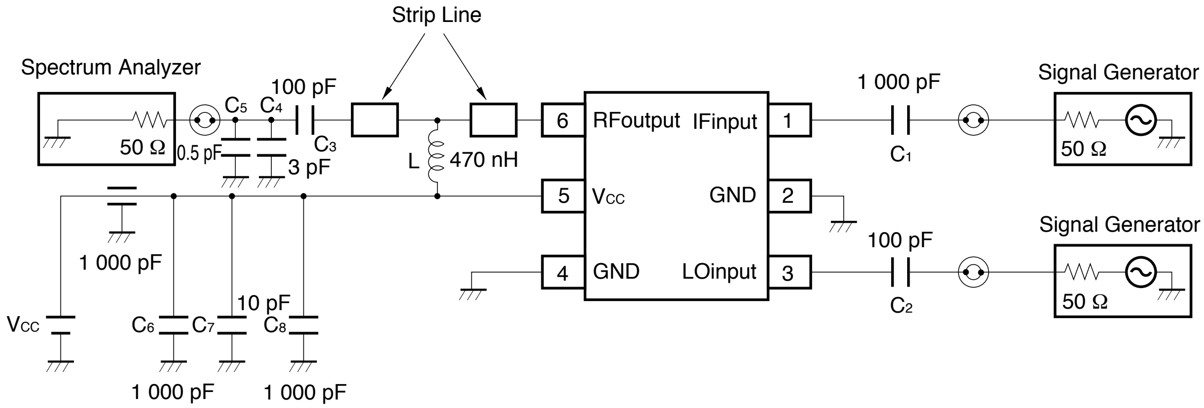
COMPONENT LIST

Form	Symbol	Value
Chip capacitor	C1, C5, C7	1 000 pF
	C2, C4	100 pF
	C6	10 pF
	C3	4 pF
Chip inductor	L	2.2 nH[Note]

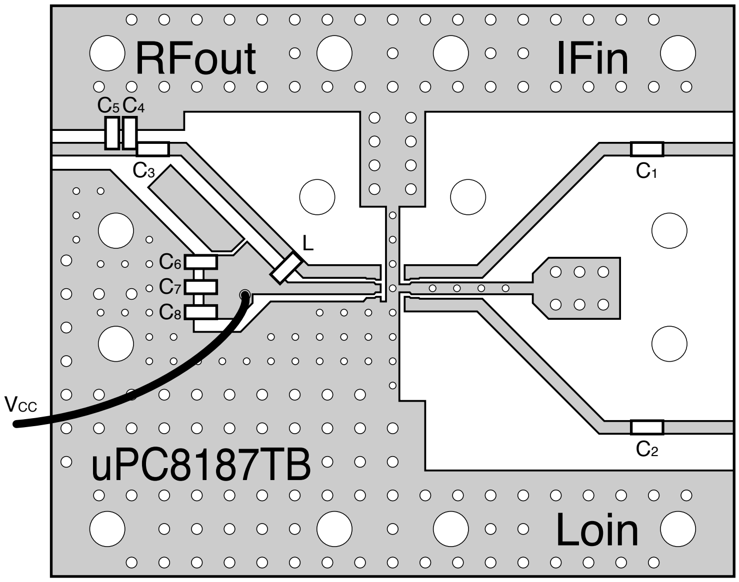
(∗1) 35 × 42 × 0.4 mm polyimide board, double-sided copper clad
(∗2) Ground pattern on rear of the board
(∗3) Solder plated patterns
(∗4) ○◯◯ : Through holes
(∗5) ▨ : Join patterns with electrical tape

Note 2.2 nH: LL1608-FH2N25 (TOKO Co., Ltd.)

10.2 TEST CIRCUIT 2 (f_{RFout} = 1.9 GHz)



EXAMPLE OF TEST CIRCUIT 2 ASSEMBLED ON EVALUATION BOARD



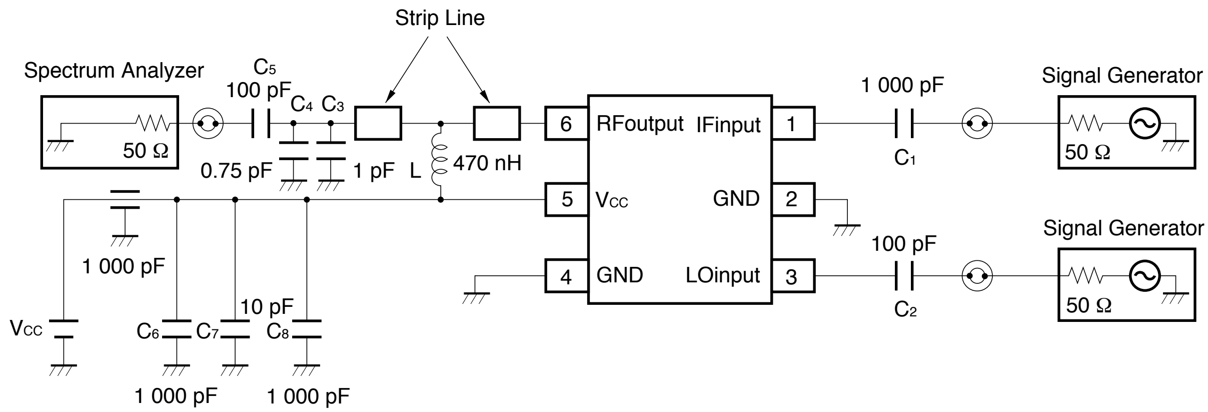
COMPONENT LIST

Form	Symbol	Value
Chip capacitor	C1, C6, C8	1 000 pF
	C2, C3	100 pF
	C7	10 pF
	C4	3 pF
	C5	0.5 pF
Chip inductor	L	470 nH Note

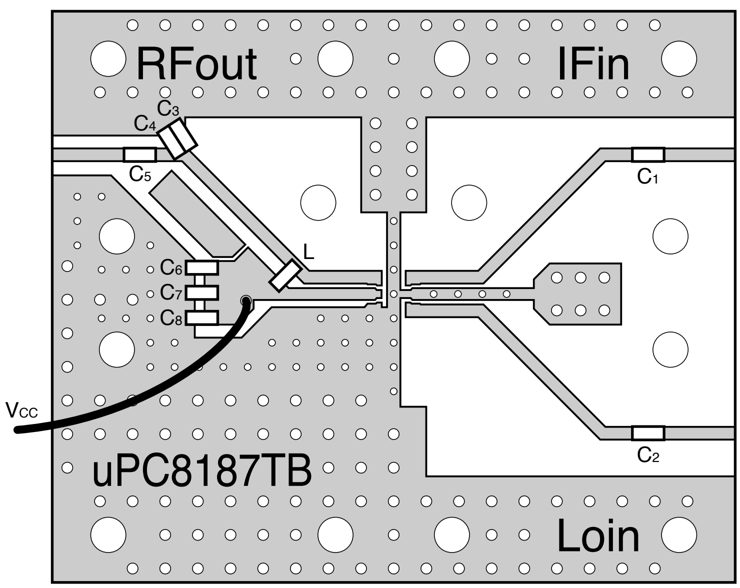
(∗1) 35 × 42 × 0.4 mm polyimide board, double-sided copper clad
(∗2) Ground pattern on rear of the board
(∗3) Solder plated patterns
(∗4) ○○◯ : Through holes

Note 470 nH: LL2012-FR47 (TOKO Co., Ltd.)

10.3 TEST CIRCUIT 3 (f_{RFout} = 2.4 GHz)



EXAMPLE OF TEST CIRCUIT 3 ASSEMBLED ON EVALUATION BOARD



COMPONENT LIST

Form	Symbol	Value
Chip capacitor	C1, C6, C8	1 000 pF
	C2, C5	100 pF
	C7	10 pF
	C3	1 pF
	C4	0.75 pF
Chip inductor	L	470 nH[Note]

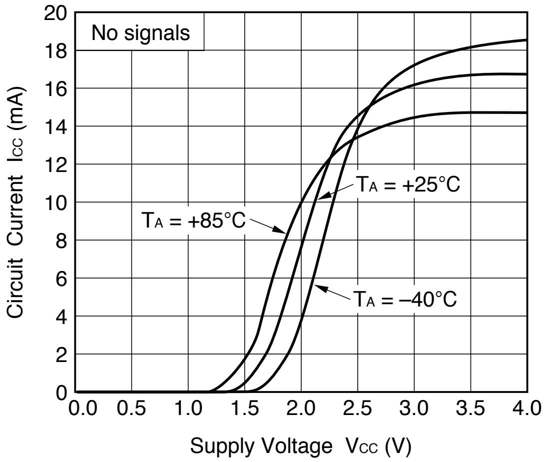
Note 470 nH: LL2012-FR47 (TOKO Co., Ltd.)

(*1) 35 × 42 × 0.4 mm polyimide board, double-sided copper clad
(*2) Ground pattern on rear of the board
(*3) Solder plated patterns
(*4) ◦○◯ : Through holes

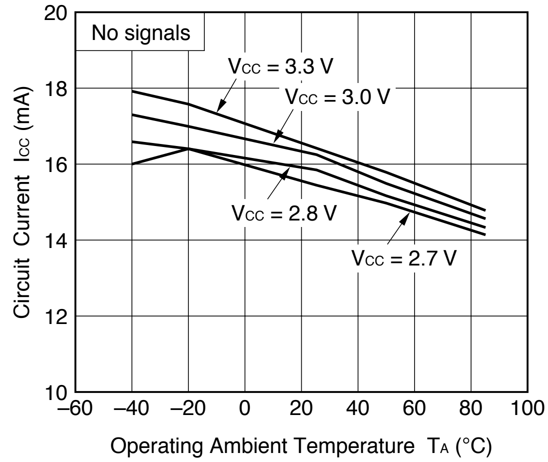
Caution The test circuits and board pattern on data sheet are for performance evaluation use only (They are not recommended circuits). In the case of actual design-in, matching circuit should be determined using S-parameter of desired frequency in accordance to actual mounting pattern.

★ 11. TYPICAL CHARACTERISTICS (Unless otherwise specified, T_A = +25°C, V_{CC} = V_{RFout})

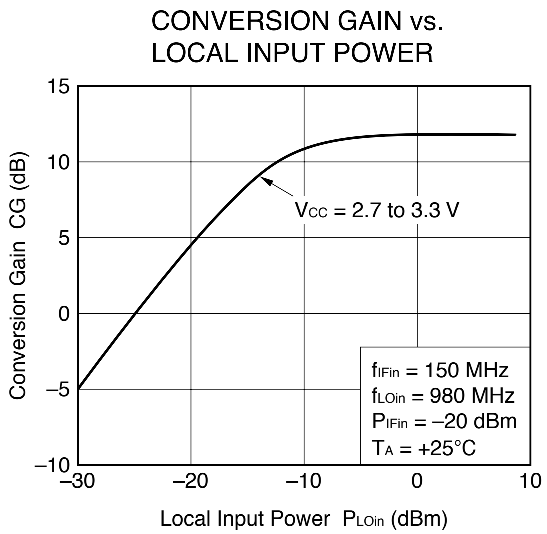
CIRCUIT CURRENT vs. SUPPLY VOLTAGE

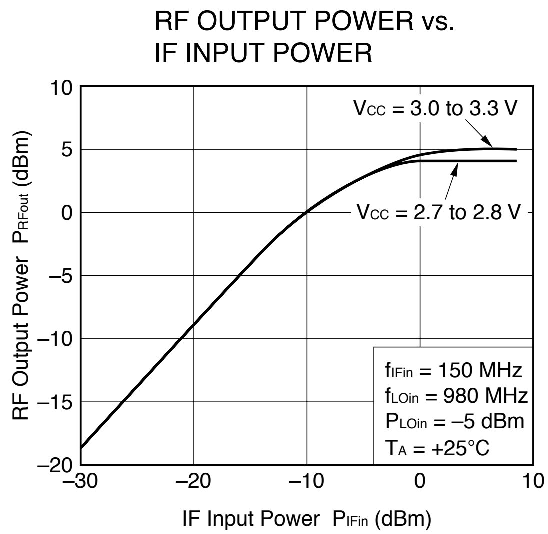


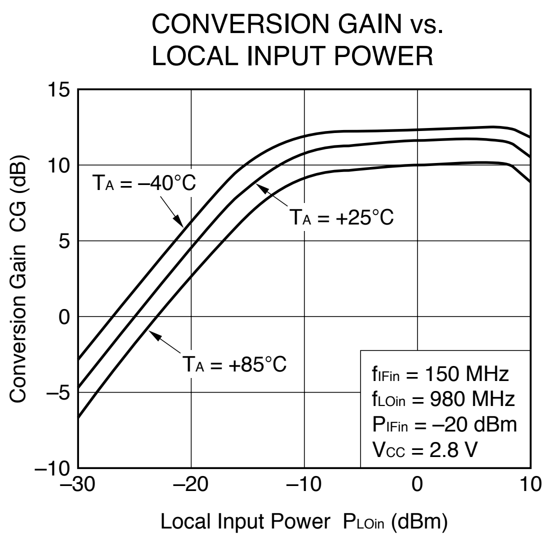
CIRCUIT CURRENT vs. OPERATING AMBIENT TEMPERATURE

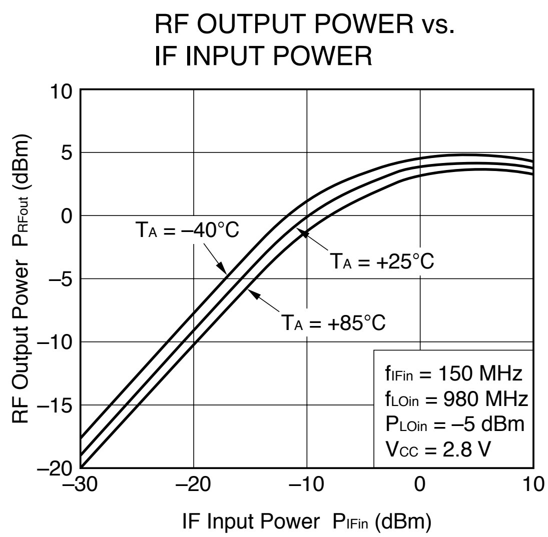


11.1 f_{RFout} = 0.83 GHz

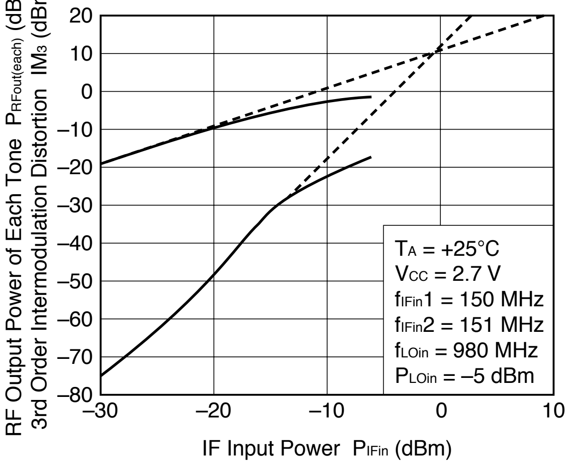




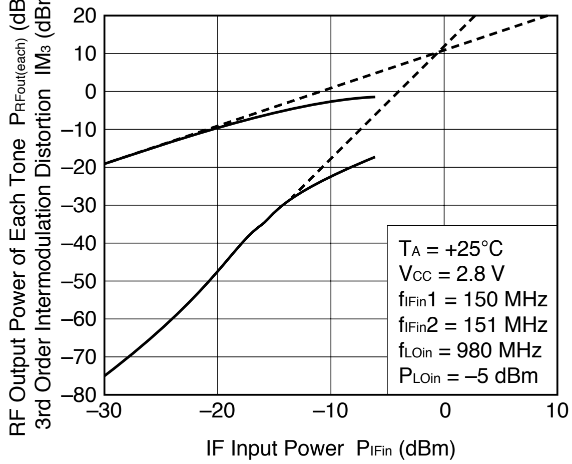




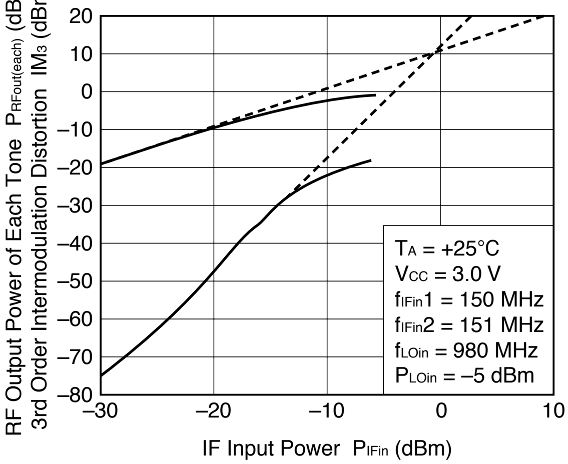
RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER



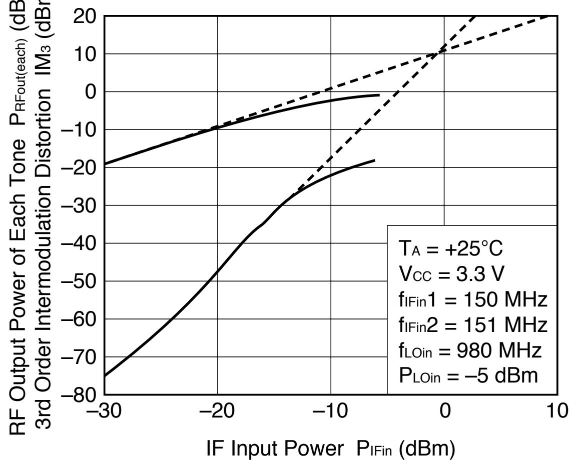
RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER



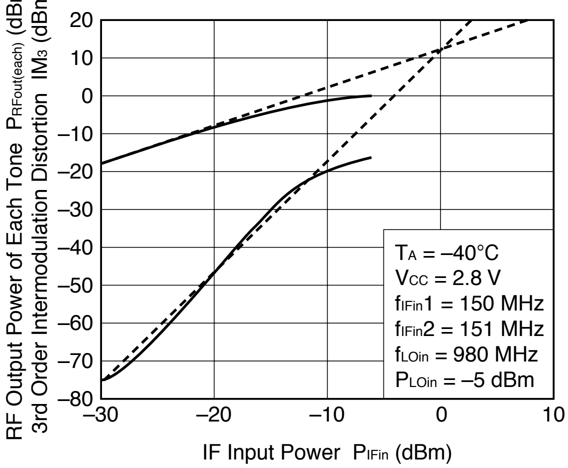
RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER



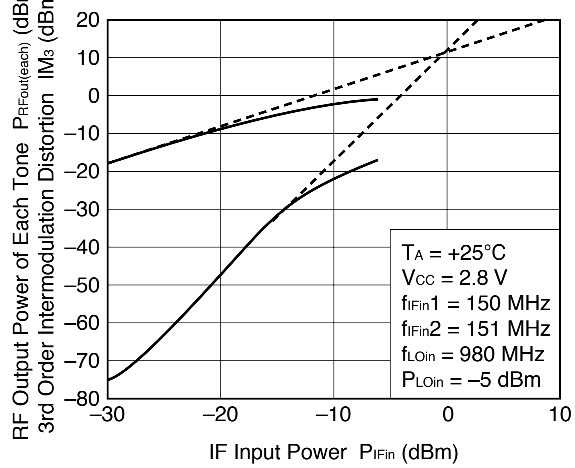
RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER



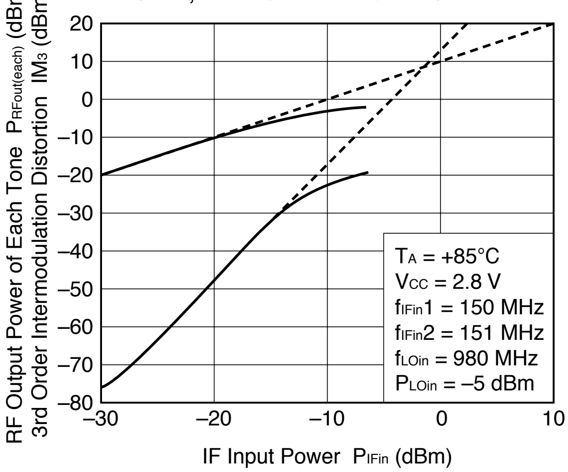
RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER



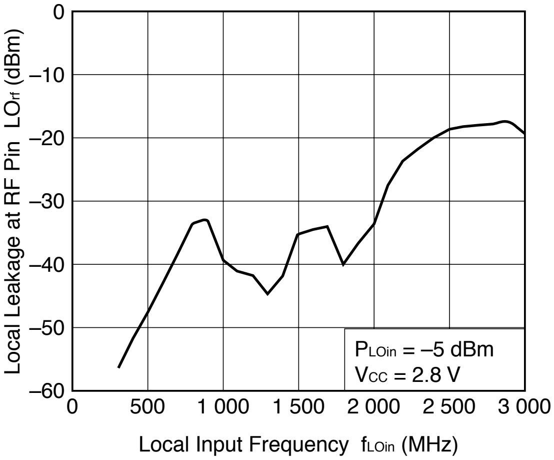
RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER



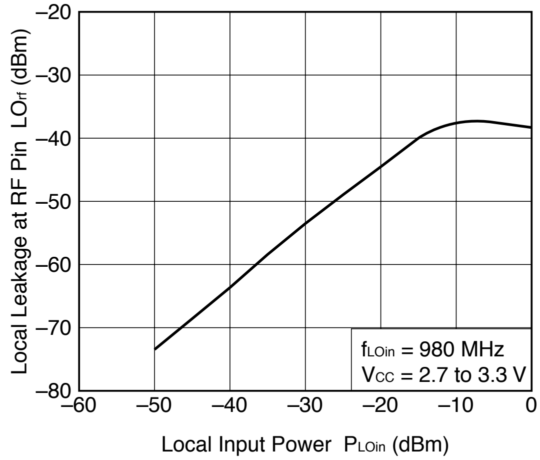
RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER



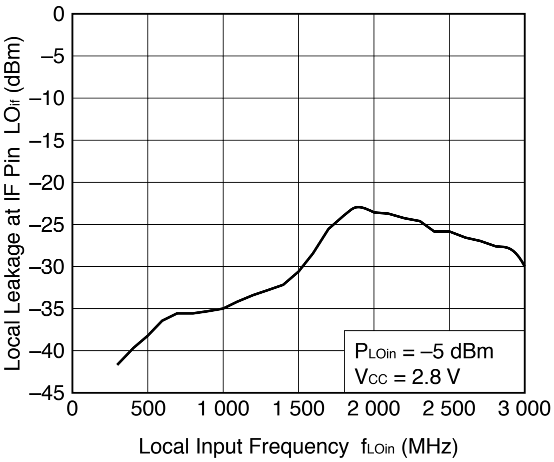
LOCAL LEAKAGE AT RF PIN vs.
LOCAL INPUT FREQUENCY



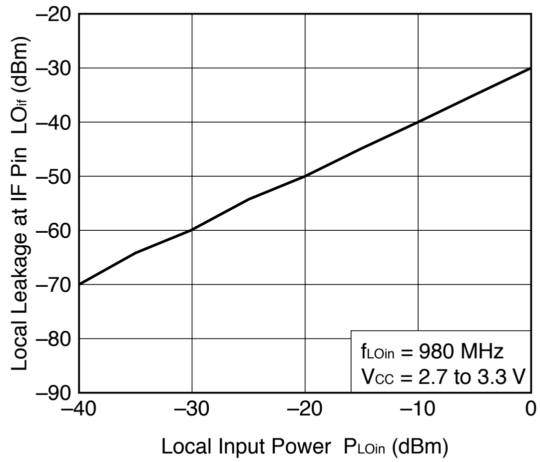
LOCAL LEAKAGE AT RF PIN vs.
LOCAL INPUT POWER



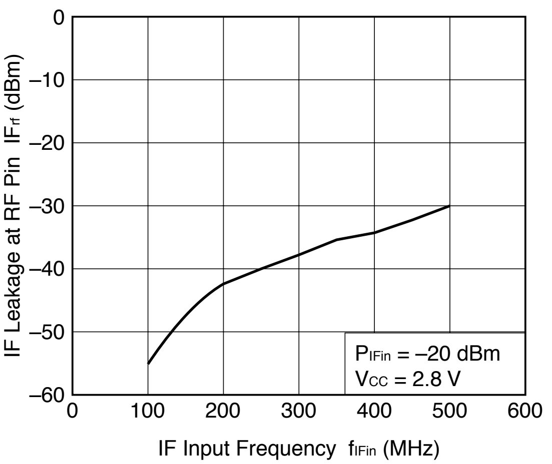
LOCAL LEAKAGE AT IF PIN vs.
LOCAL INPUT FREQUENCY



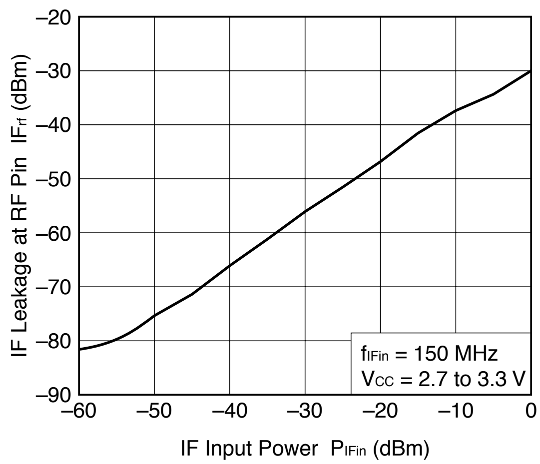
LOCAL LEAKAGE AT IF PIN vs.
LOCAL INPUT POWER



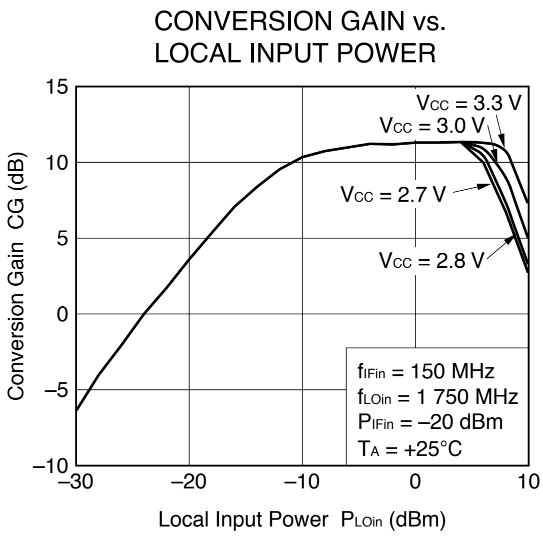
IF LEAKAGE AT RF PIN vs.
IF INPUT FREQUENCY

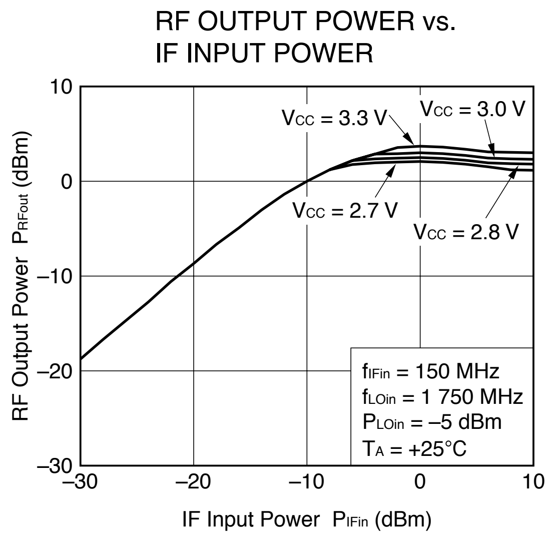


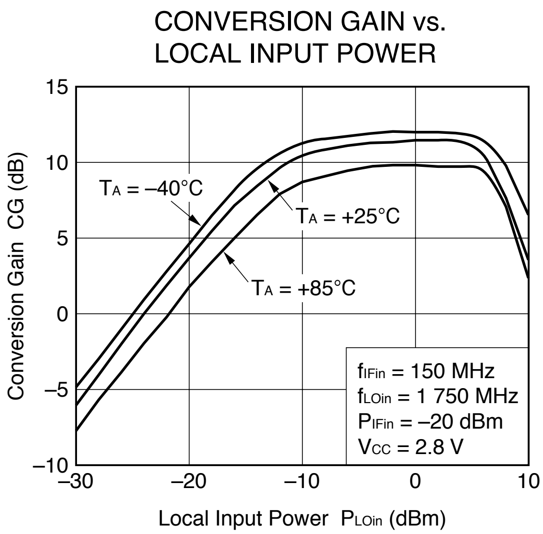
IF LEAKAGE AT RF PIN vs.
IF INPUT POWER

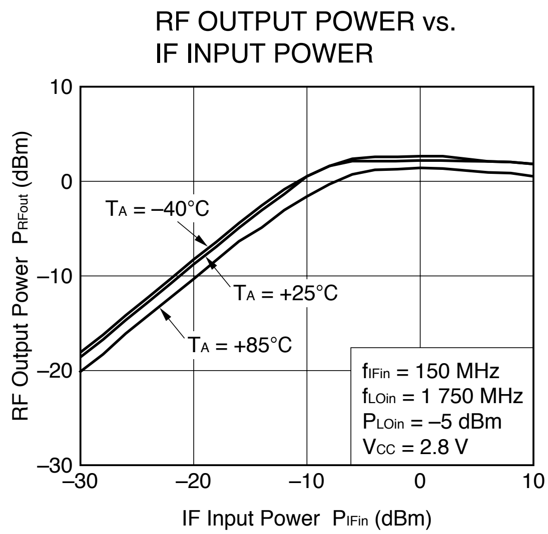


11.2 f_{RFout} = 1.9 GHz

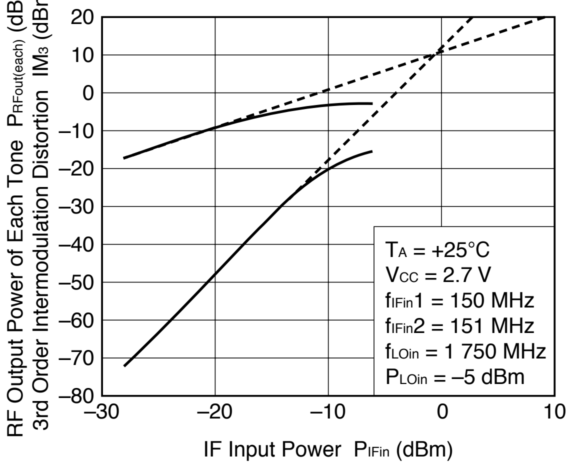




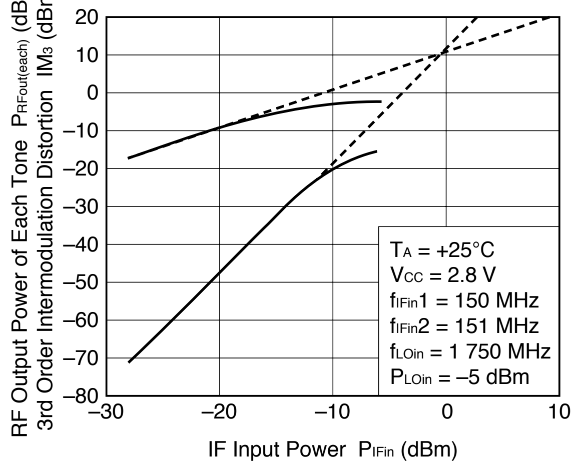




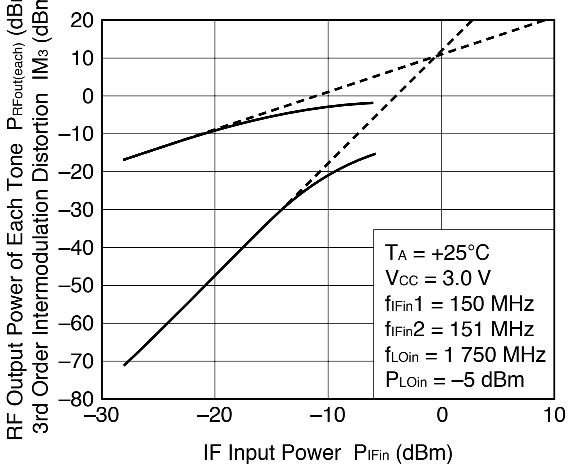
RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER



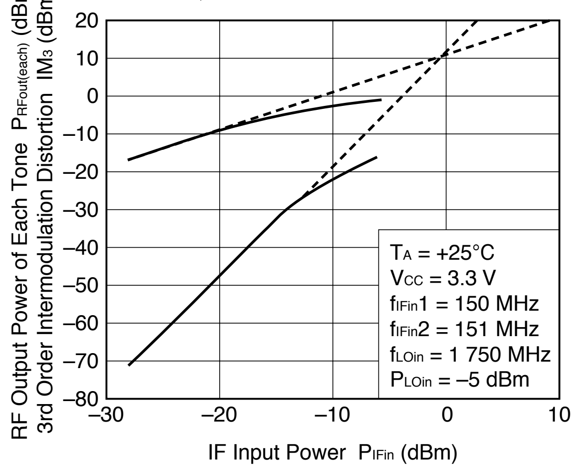
RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER

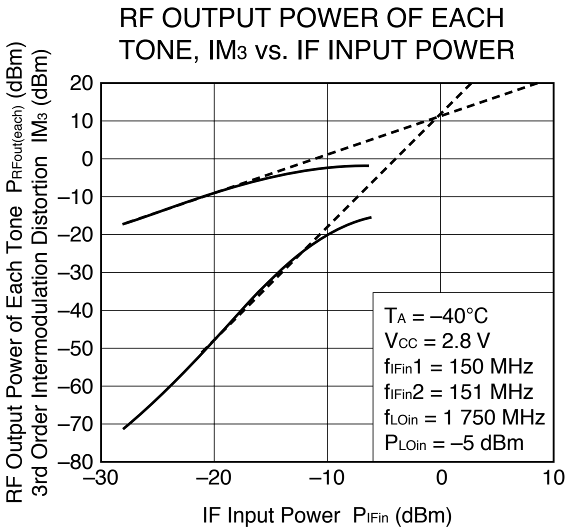


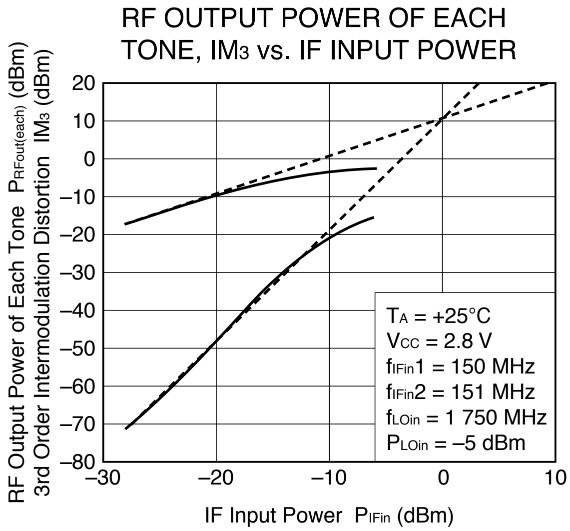
RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER

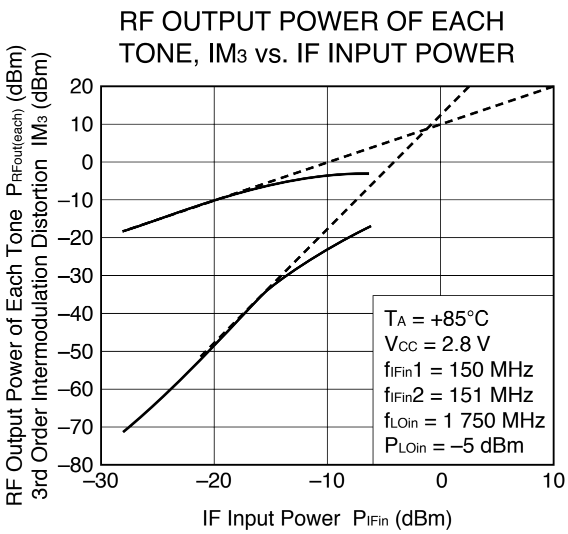


RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER




RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER
RF Output Power of Each Tone PRFout(each) (dBm)
3rd Order Intermodulation Distortion IM3 (dBm)
IF Input Power PIFin (dBm)
TA = –40°C
VCC = 2.8 V
fIFin1 = 150 MHz
fIFin2 = 151 MHz
fLOin = 1 750 MHz
PLOin = –5 dBm


RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER
RF Output Power of Each Tone PRFout(each) (dBm)
3rd Order Intermodulation Distortion IM3 (dBm)
IF Input Power PIFin (dBm)
TA = +25°C
VCC = 2.8 V
fIFin1 = 150 MHz
fIFin2 = 151 MHz
fLOin = 1 750 MHz
PLOin = –5 dBm


RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER
RF Output Power of Each Tone PRFout(each) (dBm)
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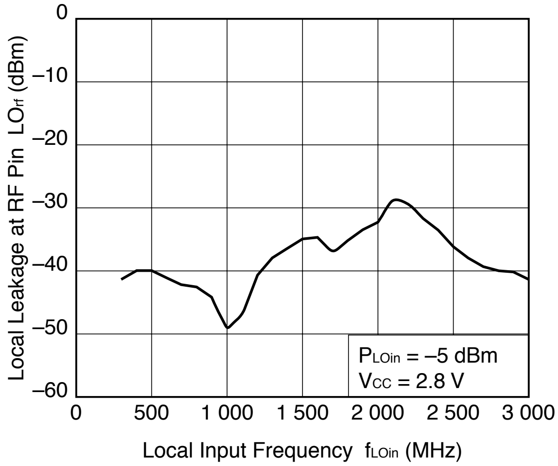
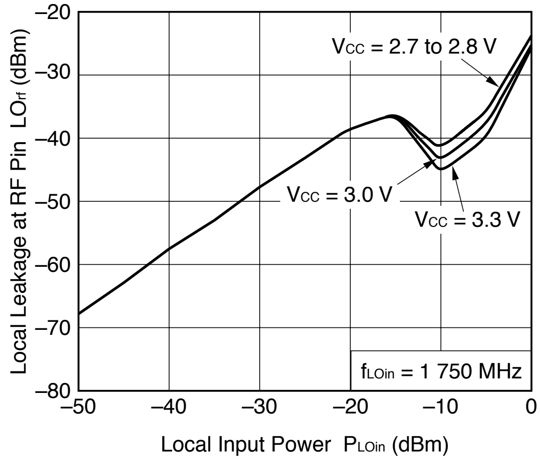
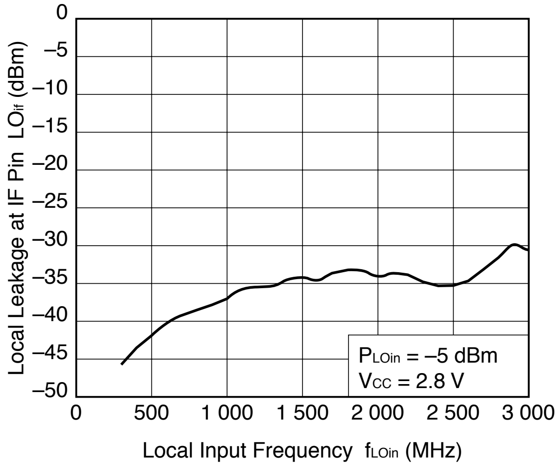
LOCAL LEAKAGE AT RF PIN vs.
LOCAL INPUT FREQUENCY



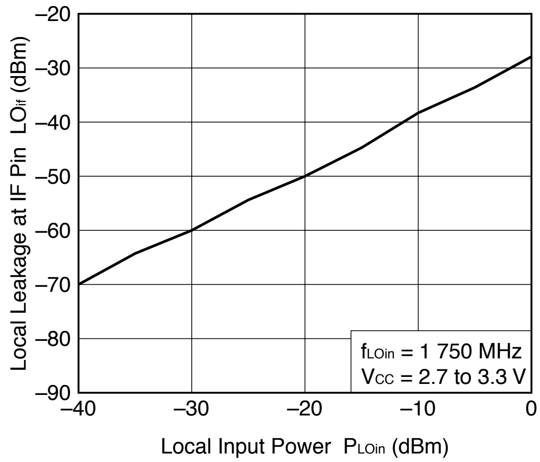
LOCAL LEAKAGE AT RF PIN vs.
LOCAL INPUT POWER



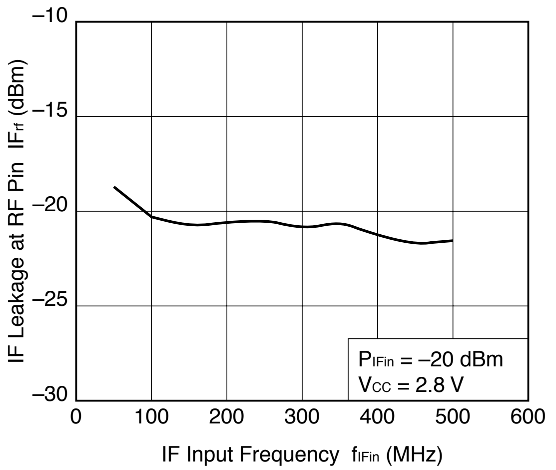
LOCAL LEAKAGE AT IF PIN vs.
LOCAL INPUT FREQUENCY



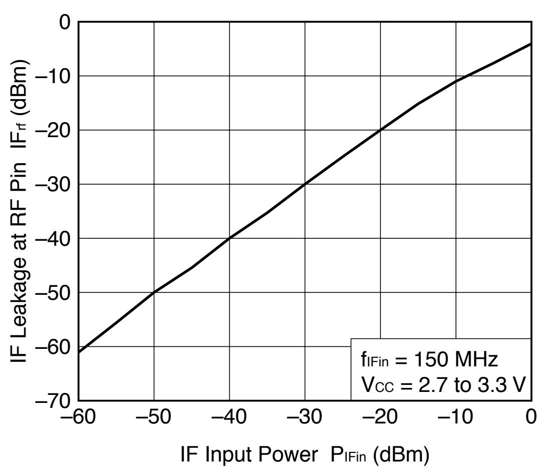
LOCAL LEAKAGE AT IF PIN vs.
LOCAL INPUT POWER



IF LEAKAGE AT RF PIN vs.
IF INPUT FREQUENCY

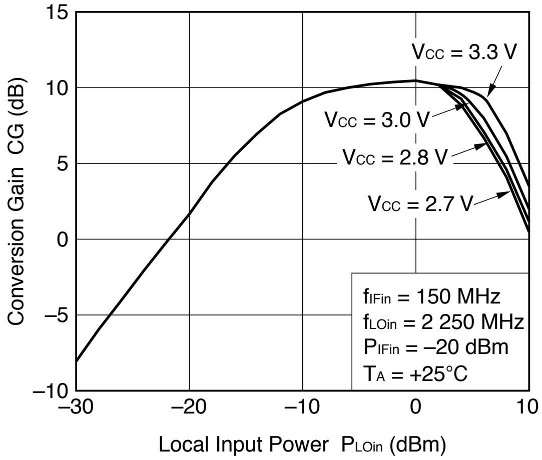


IF LEAKAGE AT RF PIN vs.
IF INPUT POWER

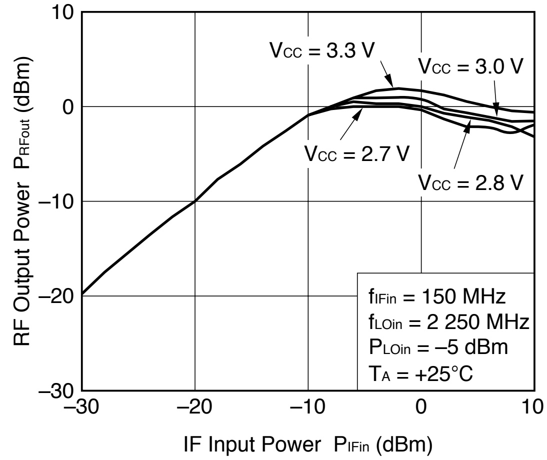


11.3 f_{RFout} = 2.4 GHz

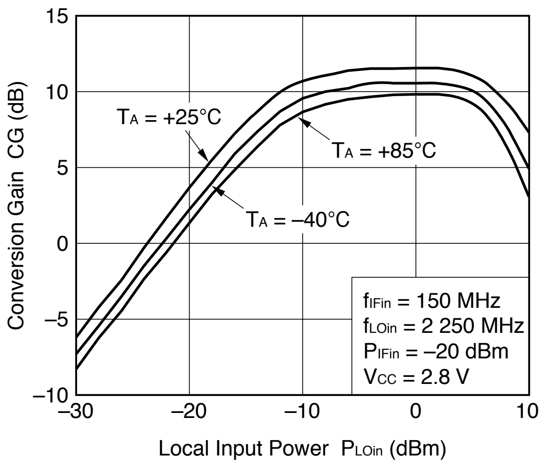
CONVERSION GAIN vs.
LOCAL INPUT POWER



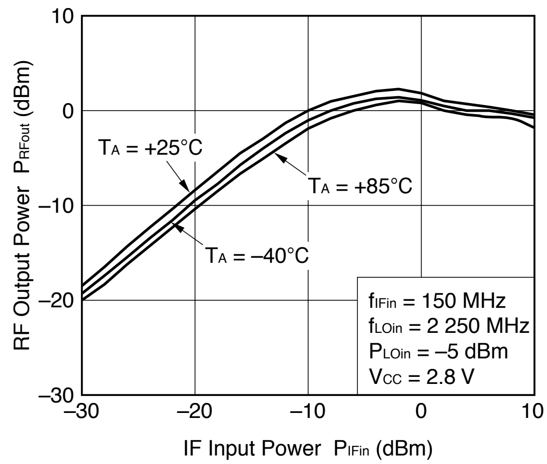
RF OUTPUT POWER vs.
IF INPUT POWER



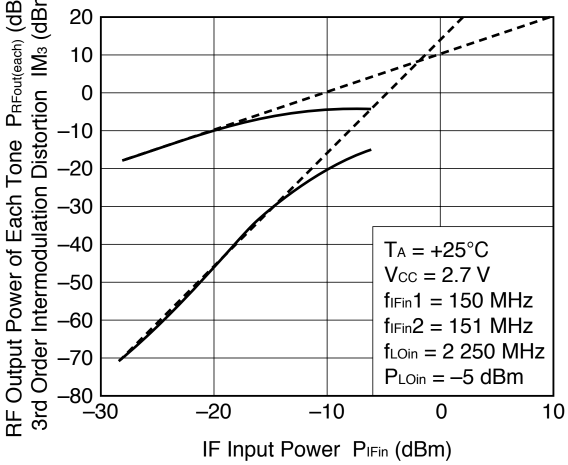
CONVERSION GAIN vs.
LOCAL INPUT POWER



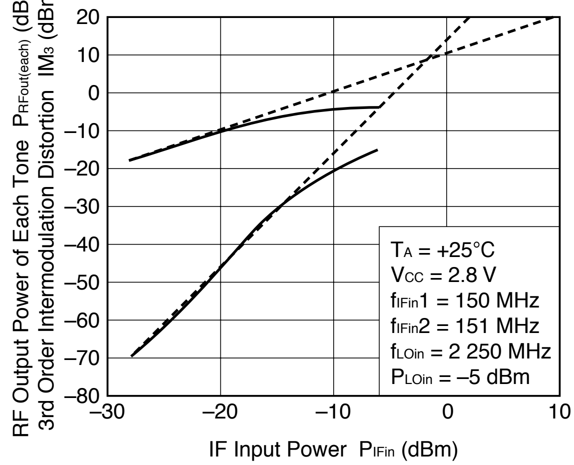
RF OUTPUT POWER vs.
IF INPUT POWER



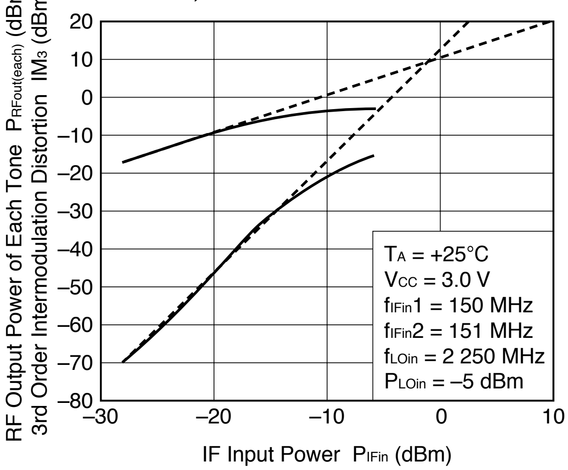
RF OUTPUT POWER OF EACH TONE, IM_3 vs. IF INPUT POWER



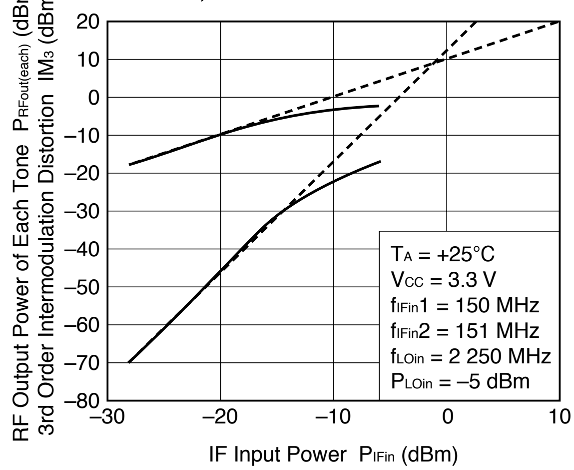
RF OUTPUT POWER OF EACH TONE, IM_3 vs. IF INPUT POWER

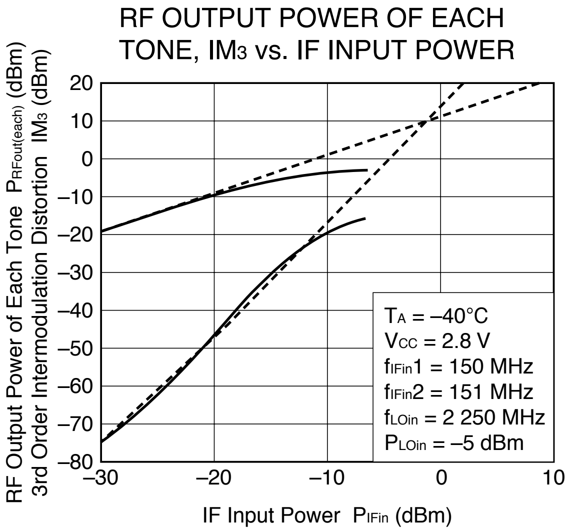


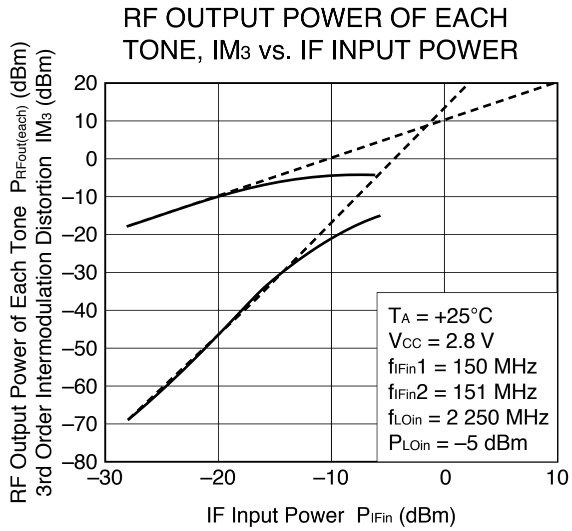
RF OUTPUT POWER OF EACH TONE, IM_3 vs. IF INPUT POWER



RF OUTPUT POWER OF EACH TONE, IM_3 vs. IF INPUT POWER




RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER
RF Output Power of Each Tone PRFout(each) (dBm)
3rd Order Intermodulation Distortion IM3 (dBm)
20
10
0
–10
–20
–30
–40
–50
–60
–70
–80
–30
–20
–10
0
10
IF Input Power PIFin (dBm)
TA = –40°C
VCC = 2.8 V
fIFin1 = 150 MHz
fIFin2 = 151 MHz
fLOin = 2 250 MHz
PLOin = –5 dBm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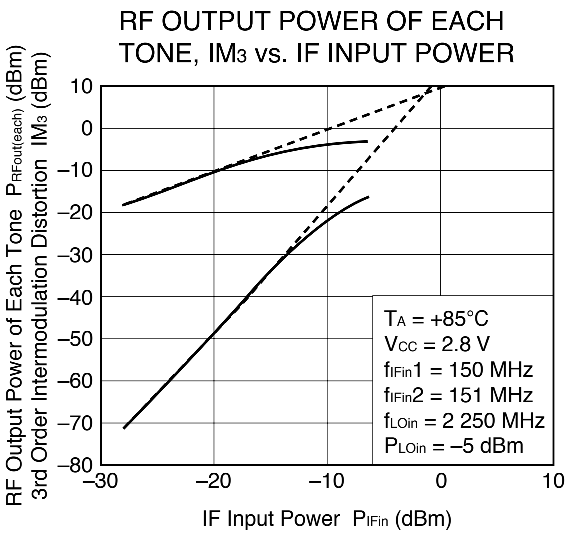
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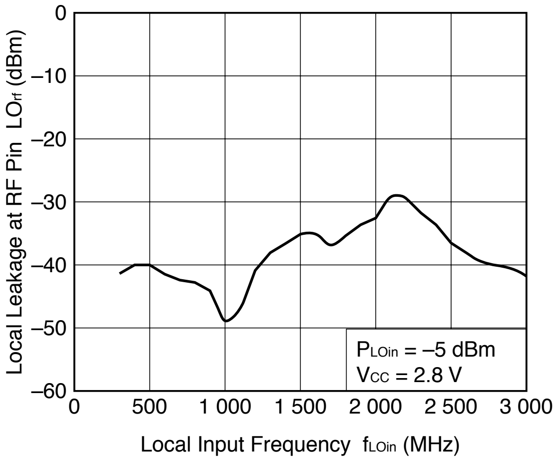
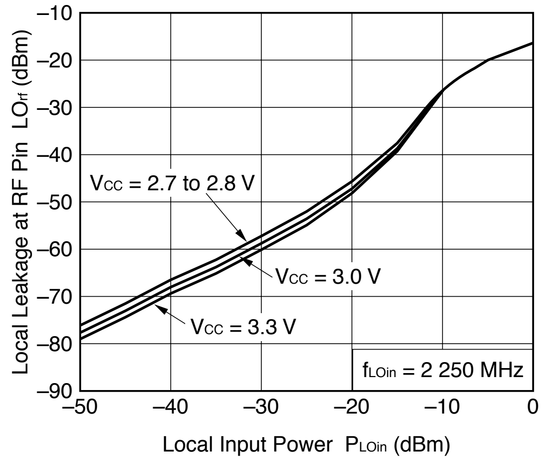
RF Output Power of Each Tone PRFout(each) (dBm)
3rd Order Intermodulation Distortion IM3 (dBm)
10
0
–10
–20
–30
–40
–50
–60
–70
–80
–30
–20
–10
0
10
IF Input Power PIFin (dBm)
TA = +85°C
VCC = 2.8 V
fIFin1 = 150 MHz
fIFin2 = 151 MHz
fLOin = 2 250 MHz
PLOin = –5 dBm

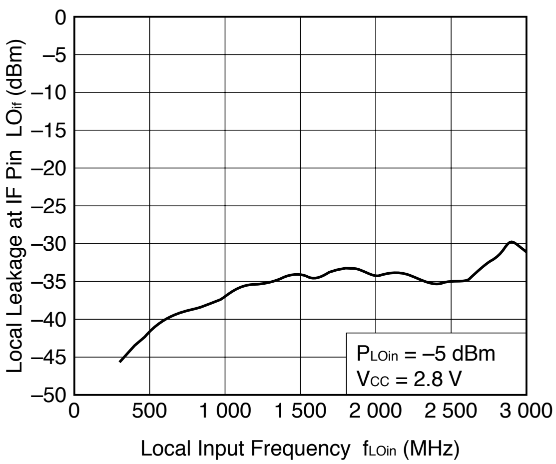
LOCAL LEAKAGE AT RF PIN vs.
LOCAL INPUT FREQUENCY



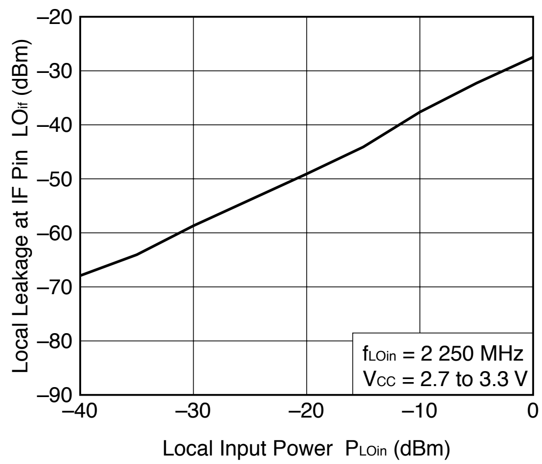
LOCAL LEAKAGE AT RF PIN vs.
LOCAL INPUT POWER



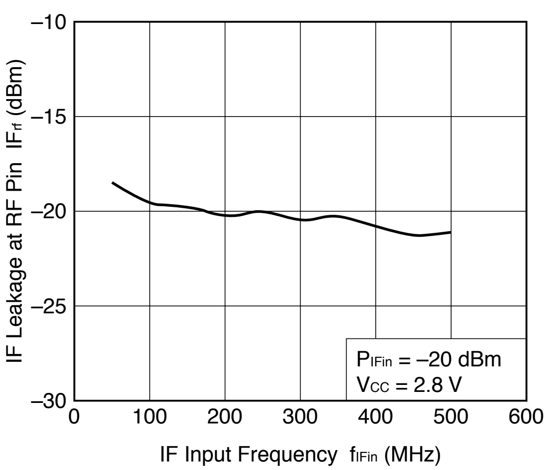
LOCAL LEAKAGE AT IF PIN vs.
LOCAL INPUT FREQUENCY



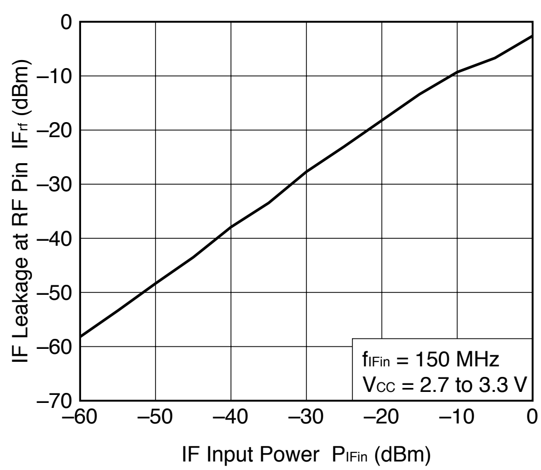
LOCAL LEAKAGE AT IF PIN vs.
LOCAL INPUT POWER



IF LEAKAGE AT RF PIN vs.
IF INPUT FREQUENCY

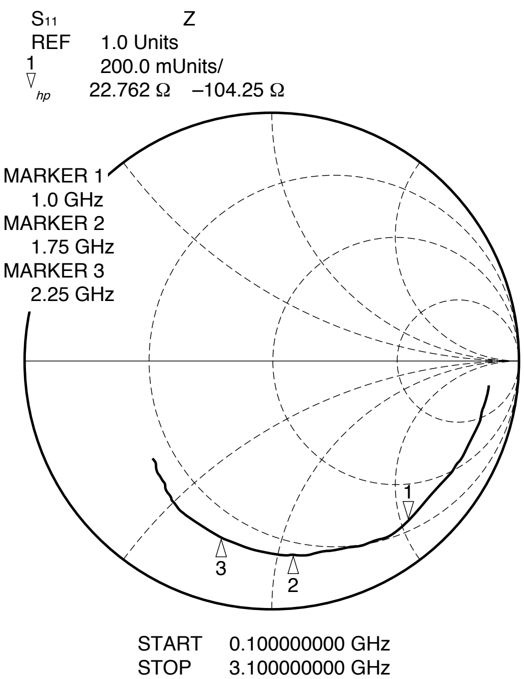


IF LEAKAGE AT RF PIN vs.
IF INPUT POWER

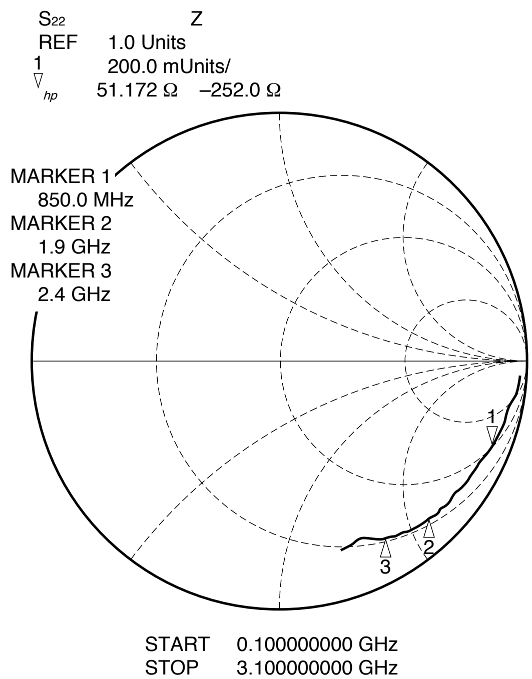


★ 12. S-PARAMETERS FOR EACH PORT ($V_{CC} = V_{RFout} = 2.8$ V)
(The parameters are monitored at DUT pins)

LO port



RF port (without matching)



IF port